It is true that there is a greater factor of safety with filtered than with unfiltered radiation, but it must be remembered that when damage is done it will extend deeper beneath the skin with filtered than with unfiltered rays because of their increased penetration.

I cannot agree with Doctor Newell on the statement that the difference between the large and small areas is much greater clinically than when physically measured, so far as these tables and the size of the doses under consideration are concerned. One would rarely use an area greater than 24 by 24 centimeters (576 square centimeters) and 800 r *when measured to include backscattering* will produce a light erythema on such an area in less than 50 per cent of individuals and a tan in about 75 per cent. It is equivalent to the minimum erythema or unit dose of radium given in the published tables of the Standardization and Research Committee of the American Radium Society. I cannot conceive of such a dose resulting in blisters except under exceptionally abnormal conditions. It must be borne in mind, however, that I refer to 800 r measured on the skin so as to include backscattering, not simply the tube output measured in air. It has long been known that many times the erythema dose may be applied to very small area without permanent damage, but such dosage must be reserved for the experienced radiologist and is beyond the scope of this paper.

I have used seven per cent as the daily recovery because it is below the eight per cent recovery for skin determined by Stenstrom and well within safe limits, as shown by the clinical results of several experienced radiologists. This factor and the reasons for its use were discussed by me in "The Relation of Fractional to Depth Dose."

It is fortunate that Doctor Desjardins stressed the importance of the clinical side of radiation therapy. It is too true that the profession as a whole considers roentgen therapy purely a technical problem and not infrequently turn their patients over to a lay technician for treatment. Roentgen therapy is primarily a clinical problem, and this paper was intended to assist the clinician and the clinician only in his difficulties with the physical aspects of formulating a dose of the roentgen rays.

In closing I wish to repeat what I said at the beginning of the paper. The recommendations and data are only the minimum requirements and are reasonably safe. To be even moderately qualified as a radiation-therapist the physician must consider them as only a few bricks with which to begin building the foundation of his knowledge.

DIFFICULT FRACTURES*

REPORT OF CASES

By W. C. ADAMS, M. D.
Oakland

DISCUSSION *by Charles A. Dukes, M. D., Oakland; Ernest W. Cleary, M. D., San Francisco; N. Austin Cary, M. D., Oakland.*

THIS paper is written, not with the thought of offering or suggesting anything new in the treatment of the commoner types of fractures. The common fractures are selected because in them lie the greatest number of problems and unsatisfactory results. In my opinion, there is no department of medicine and surgery more important than that of the treatment of fractures; the future happiness of vast numbers of injured depends on their proper treatment. Certainly major abdominal surgery, both in technique and after-care, does not overshadow the reduction of dislocations and the care of injuries to such bones as the femur and humerus. While the mortality is not so great, especially in those individuals past the age of fifty years, the expense to the injured, the loss of time from work and home, the pain endured, is greater in fractures than in the average abdominal operation. One writer (Speed) has mentioned the great ado (not unnecessarily) made over a case of acute appendicitis for which every facility of a modern hospital is thrown into action (many nurses, laboratory staff, the surgical department and special nurses for the patient) and for which the average hospital stay is but ten to twelve days. Is the equivalent amount of attention required for fracture patients who are so prone to a multitude of complications? In such important injuries as fractures the hospital selected should have ample equipment, such as proper fracture tables, portable x-rays, orthopedic room, beds with framework fitted, a selection of splints, and the technique of the operating room and staff should be above question if open operation be necessary. The surgeon in charge should make sufficiently frequent personal inspection of his patient after reduction has been started. Too often the adjustment of the apparatus is left to a student nurse or to an orderly who knows little of the pathology of the fracture or the physiology of the limb. Extension apparatus easily gets out of adjustment and the bone fragments out of alignment, so that frequent inspection by the expert is essential to the happiness and comfort of the patient and, most important, to the best functioning of the injured limb.

No set rules of treatment can be followed in any type of fracture, the proper procedure having to be worked out separately in each instance. My experience has been that the open method is the procedure of choice in fractures of the long bones when satisfactory reduction has not taken place after six to ten days of faithful application of some form of extension. In a well-appointed hospital, with a skilled surgeon, the operative method of reducing fractures is today performed with vastly increased safety. In this manner, as a rule perfect apposition of fragments is obtained and the limb restored to absolutely normal function when otherwise much unhappiness would have occurred from deformity and loss of function.

Time will not permit of any detailed discussion of types of apparatus for conservative treatment or the various methods of fixation in open operation.

The cases reported in this paper are those which were complicated with other fractures or which presented some difficult problem.

REPORT OF CASES

CASE 1.—Lester P., age eight, fell from a tree. The distal ends of the left radius and ulna were forced through the volar surface of the wrist and projected into the dirt and grass. He was cared for at a county hospital for the following five days. X-rays taken there showed that the distal end of the radius had separated from the epiphysis, leaving this distal fragment in its normal articulation with the wrist.

* Read before the Industrial Medicine and Surgery Section of the California Medical Association at the fifty-ninth annual session at Del Monte, April 28 to May 1, 1930.

When I first saw the boy he was delirious, had a temperature of 102 degrees, and the arm from the mid-brachial region to and including the hand was greatly swollen and reddened—almost gangrenous. The distal ends of the radius and ulna were blackened and still protruding about two inches outside of the skin. The fascia and ligaments of the wrist joint were necrotic and exceedingly foul-smelling. I removed him immediately to an Oakland hospital and operated at once, removing all the necrotic tissue possible. Incision in the immensely swollen hand elicited no blood whatsoever. Incisions were also made into the forearm for proper drainage. With much difficulty a dorsal board splint was applied with one end projecting beyond the finger tips. With adhesive tape fixed to the fingers a strong rubber-band extension was begun. Day and night special nurses were employed to keep the arm in a continuous warm compress of 1 to 5000 bichlorid solution in a saturated magnesium sulphate solution, and twice daily the arm was placed in a full-arm bath of the same solution. After a few days we were delighted to see bright blood appearing in the hand incisions, and with it the boy's general condition improved greatly and the swelling decreased. After twelve days he left the hospital and came to the office for daily dressings. About two weeks later a full one and one-half inches of the distal ends of the radius and ulna dropped off. The extension splint was watched now more carefully to prevent shortening until the tissues would clean up sufficiently for a possible bone graft. About ten weeks from date of accident, when the tissues were pretty well healed, there was noted a very marked rigidity in the entire arm. Imagine my surprise when x-ray showed that new bone had grown from the proximal fragment of the radius and attached itself to the epiphysis which had been left behind. The distal end of the remaining ulna had formed bony union with the radius. All went well until the end of the fourth month, when he fell while playing and fractured the new bone at its middle. With further immobilization the new bone repaired itself quite rapidly. The boy was discharged at the end of the sixth month with no shortening of the arm and a good-appearing hand, although there was marked limitation of motion in all of the fingers.

* * *

Case 2.—W. W., a carpenter's helper, age twenty-five. Fell from a second-story floor of a building under construction, rendering him unconscious. When I first saw him at a hospital the following day, he was still irrational and attempting to get out of bed. X-ray showed fracture of both femora through their middle thirds—that of the left being compound—with fully four inches of proximal displacement of both lower fragments. There was also fracture of the right patella and three fractures of the mandible with marked displacement of fragments. This last condition complicated matters greatly, for it was necessary to wire the upper and lower teeth firmly together, making it impossible to give a general anesthetic.

Thomas extension with adhesive traction was applied to both legs for a period of three weeks. Reduction not taking place, skeletal traction of ice tongs was attempted with no better results. His general condition was so serious at this time, it was necessary that something radical be done at once. The wires on his teeth were removed and, under general anesthesia, both femurs were plated with Lane plates. By this time much bony callus had formed which it was necessary to clear away. Sixteen days after the operation, sloughing of the callus in the left leg took place and after ample drainage quickly cleared up. X-rays showed no infection of the bone. Bony union took place promptly. When seen one year after injury there was but 22 degrees limitation of motion in the right knee and 12 degrees in the left. He was climbing about buildings at his usual occupation.

* * *

Case 3.—Douglas N., special delivery boy for a newspaper, age sixteen. While riding his bicycle he was struck by an automobile, causing an incomplete fracture of the left radius three inches from the wrist-joint, and a complete fracture of the radius and ulna of the same arm three inches below the elbow, with marked dorsal displacement of both. There was a comminuted fracture of the left femur in the upper third with the distal fragment displaced two inches proximally, medially, and dorsally. The radius and ulna were fixed with Lane plates, and after eleven days of a Thomas extension on the femur without results, a Dukes bone plate was used. This plate I found to be excellent, as it made a second operation to remove a Lane plate through the deep muscle tissues unnecessary. Bony union took place without incident and the Dukes plate was removed at the end of the seventh week. The plaster spica was removed at the end of the eighth week and the injured allowed to begin some weight bearing, aided with crutches. He was discharged to his usual duties in five and one-half months.

* * *

Case 4.—John H., machinist, age fifty-one. His jumper sleeve became caught in a large revolving shaft, winding his left arm about it. The entire arm was like a flail. The patient was in severe shock from being whirled about the shaft. He sustained a spiral fracture of the left humerus at the junction of the lower and middle thirds with marked displacement of the fragments; also extensive fractures of the left radius and ulna with wide separation of the fragments—that of the ulna was compound. Thomas extension was used on all of the fractures. The humerus not responding in fifteen days, a Lane plate was applied, the ulna was wired and the arm was returned to the Thomas extension to keep the numerous fragments of the radius in alignment. The extension was removed after nineteen days and a plaster dressing applied. Physiotherapy was started four weeks after operation. The contour of the arm was such that it was not evident that a fracture had taken place. Some limitation of flexion of the fingers remained, although the patient returned to his usual duties.

* * *

Case 5.—Mrs. T., age fifty. Married. Housewife. Stepped from an automobile to a very deep gutter at night and, misjudging the depth of the gutter, severely wrenched her left leg. She was not seen by the writer until two days later. The lower one-third of the leg was markedly swollen and flail-like. X-ray showed a spiral fracture of the lower one-third of the left tibia with lateral and proximal displacement of the distal fragment; a fracture through the posterior one-third of the distal articular surface of the tibia which allowed marked anterior displacement of the anterior fragment on the astragalus. The distal end of the left fibula was fractured. Under gas anesthesia the writer was able, with very strong traction on the foot, to manipulate all of the fragments into a satisfactory reduction. The entire leg to the hip was placed in a plaster dressing for ten weeks. Weight bearing was permitted in twelve weeks. Patient recovered without any apparent limp. This was one of those cases in which one was able, in a comfortable manner, to get out of a difficult situation, extension splints or open methods not being necessary.

* * *

Case 6.—Captain F. W., captain of a sailing vessel, age fifty. An extremely large man, weighing two hundred and fifty pounds, fell through a hatchway a distance of fifteen feet. When seen at the hospital he was in considerable shock and expectorating blood from the lungs. This case was interesting because of the multiplicity of fractures and complications. There was a fracture of the surgical neck of the right humerus with some separation of the fragments, fractures of the distal ends of both radii with typical Colles' displacement, and fracture of right third and fourth ribs with evidences of a punctured lung, namely, expectoration of blood, and air in the subcutaneous tissues. The right shoulder and wrist were

placed in Thomas extension in extreme abduction until shock had subsided and danger of pneumonia had passed. He did develop an infection in the right lung, temperature ranging about 104 degrees. When this infection had subsided, the wrist fractures were reduced under gas anesthesia and put up in a plaster dressing and the shoulder was put up in a modified aeroplane plaster dressing in semi-abduction, x-rays showing that complete reduction of the humeral fracture was effected by this amount of abduction. The shoulder immobilization was removed in four weeks from the date of application, and physiotherapy was instituted. Complete recovery from the shoulder injury has occurred.

I like semi-abduction for these fractures of the neck of the humerus whenever possible because it is sufficient to allow prompt return of complete motion in the joint, and it is a very comfortable position. The shoulder held in extreme abduction is so often very painful from impingement of the greater tuberosity on the acromion process.

Case 7.—Robert B., stevedore, age forty-eight. While at work on the deck of a ship, stepped into a loop of steel cable attached to a crane. The loop suddenly tightened, almost amputating the left leg at its lower third. Both the tibia and fibula and the extensor muscles and soft tissues were crushingly severed, fortunately leaving the posterior one-third of the leg intact, including the flexor tendons, vessels, and nerves. Of course, the wound was very dirty and contaminated. The injury was so severe and extensive that amputation was seriously considered. There was seen, however, to be considerable circulation remaining in the foot, so an effort was made to restore the leg. A Dukes bone plate was applied to the tibia and the soft tissues approximated as well as possible and the leg put up in plaster. As was expected, infection developed in the bones. The screws loosened because of suppuration, necessitating complete removal of the bone plate. One to five thousand bichlorid in saturated magnesium sulphate solution was used as irrigation and wet compresses. The plaster dressing was reinforced with a right-angled posterior steel splint and all the plaster cut away from the site of injury, making dressing more convenient. Extension by skeletal traction was not employed because of the close proximity to this profusely discharging wound. At ten weeks new bone was shown by x-rays. Seven months from date of injury the patient was walking about and placing full weight upon the leg. Small fragments of bone have discharged at various intervals. At the tenth month a small area of osteomyelitis deep in the shaft of the tibia developed which cleared up quickly after curetting. Recent x-rays show dense bony union.

SUMMARY

In conclusion, I feel that in these long bone fractures with displacement of fragments we frequently wait too long before open operation is done. We should use our best judgment and decide early the need for operation, for the earlier the decision the sooner and better the outcome.

Open operation offers the advantage of perfect reduction and alignment of fragments, better assurance of bony union, better and quicker joint and muscle function because of the markedly lessened time of immobilization, and a much lessened expense to both the insurance carrier and the injured.

1904 Franklin Street.

DISCUSSION

Charles A. Dukes, M. D. (426 Seventeenth Street, Oakland).—The paper by Dr. W. C. Adams incorporates not only the science of treatment of fractures, but also the art.

Certainly no first-class carpenter would go to a job without his own tools, but how freqcently we see going to the surgery men who have scheduled a certain class of bone work in a hospital where they are not acquainted with the operating staff, nor with the instruments which are available. The screws may not be the right length, the plates not adaptable and the drills that are ready not the proper size, and dies cannot be found. Too careful attention cannot be given to the instruments before doing fracture surgery.

I feel grateful to Doctor Adams for mentioning the Dukes external bone plate, as I have been quite successful in using it in the type of fracture with which he has dealt in his paper. The use of these plates, as in the use of any other method of fixation of fractured bones, must be adapted or suggested by the case in hand, as no one type of apparatus can be used in every type of fracture.

The doctor has also stressed the matter of nursing, which is so important in these severe traumatisms in which the injury to the soft part is great.

Ernest W. Cleary, M. D. (490 Post Street, San Francisco).—Doctor Adams has presented a strong brief for early operative treatment of selected severe cases. I congratulate him heartily on the fine results shown by his x-rays and case records.

Surely, as he says, every hospital which attempts to give service for major fractures should have all the special equipment mentioned. The necessity for high standards of operating-room technique and nursing service, are, I think, paramount. Some of us have learned by bitter experience that fine equipment does not always mean safe technique in a hospital. Hospitals where mediocre standards prevail may get by with soft-tissue surgery and yet be dangerously inadequate for major bone and joint surgery.

Certainly time can be saved and often better function restored by early operation on a fracture. Recognizing this, even the most conservative of bone and joint surgeons take advantage of the increased safety afforded by better and more widely available hospital facilities. We are operating on fractures more often now than ever before, but the best surgical and hospital technique ever yet produced cannot make a contaminated field safe for a bone operation, and the results obtainable by the best conservative methods so nearly approximate the best results that may be obtained by operation that reckless operative surgery is inexcusable.

Overenthusiasm for operative treatment of fractures has its grave consequences. To be a safe bone and joint operator a surgeon must be wise and guarded in his selection of cases—meticulously careful in his own technique and exacting in his requirements for operating-room technique and pre- and postoperative care. Surgeons who are less discriminating will too often bring sorrow and disaster to their patients and themselves and discredit to the procedures which they undertake.

Always should the bone and joint surgeon beware of introducing into his fracture problem dangerous, perhaps uncontrollable, factors. I am convinced that the application of any sort of foreign body fixation to bone through a frankly contaminated or a doubtful operative field may, in many instances, introduce a factor of uncontrollable infection. Surgeons who are led to take such chances doubtless will have many brilliant results, but they will also have on their consciences some avoidable deaths and too many devastating infections.

Every type of fracture, which is ever amenable to open operative treatment, is also met with rather frequently, accompanied by complications, or in an environment such that operation is unwise or impracticable. No surgeon who is not a master of the best conservative methods of handling difficult fractures should ever operate upon such cases. The masters of conservative methods know that good functional results may be obtained by conservative treatment in

practically every case of fracture which will yield good results from operation. Such surgeons will not set the stage for a disastrous, perhaps fatal, infection by operating upon bone through an unsafe or contaminated field. Always when they must deal with contaminated fields of operation they will confine their procedures to such cleansing and redressment as is best compatible with the patient's safety. Practically never will they introduce foreign body fixation into a contaminated field. They will play safe rather than take a gambler's chance on saving time or obtaining a particularly quick and brilliant result.

I have gotten good results in cases similar to Doctor Adams' Case No. 7 (an extensively comminuted, compounded and contaminated fracture of both bones just above the ankle joint) by conservative methods, using a Thomas splint, celluloid-acetone adhesive foot piece for traction and Carrell-Dakin irrigation of the wound. For safety sake I do not use internal foreign body fixation on such cases.

I once knew a youth who, while handling dynamite, always put the giant-powder cap into his mouth and crimped it upon the fuse with his teeth. Cap-crimping pliers were provided, but this youth said he knew a man whose hand was blown off while crimping a cap with pliers. For himself, he preferred to crimp them delicately with his teeth. If the cap exploded, well—at least he would not be a cripple. I think such reasoning should never be applied in bone surgery.

*

N. Austin Cary, M. D. (2939 Summit Street, Oakland).—Doctor Adams, I am sure, has a clear insight into the fracture situation. He impresses me with the belief that as the result of experience he approaches the problem of difficult fractures with but one thought in mind—the ultimate end results.

It must be remembered there is no one method applicable to all fractures. Manipulation, traction (both skin and skeletal), and open reduction all play their rôle and will, in given cases, be of use in turn. The proper choice must be the result of experience over a long period.

Our experiences in these fractures follow fairly fixed principles. Reduction is necessary for good functional results, not necessarily to correct overriding as much as alignment to assure normal function. At times this can only be obtained by open reduction; with the laws of good surgery governing, there should be little difficulty.

In open reductions I would urge a greater respect for the soft tissues, especially about the site of fracture, as I believe this occasions most of our delayed unions and nonunions. This, with inadequate fixation and the use of inadequate materials, give the greater number of poor results. At times there is too much fussing with a good functional result trying to obtain an ideal x-ray result. Functional results should always be our criteria of treatment.

*

Doctor Adams (Closing).—I wish to thank Doctors Cleary, Dukes, and Cary for their frank and instructive discussions. I do not wish to convey the impression that wholesale open reductions be done on fractured bones, for it will be noted that I presented two case records where the conservative closed reduction was done. However, I do feel that too often we see great disability due to stiffened joints and muscular atrophy caused by such long periods of necessary immobilization, especially when nonunion or bad deformity has resulted after two or three months, and then more immobilization superimposed because a delayed operation has become necessary for their correction. These stiffened joints and muscle damage so frequently cause irreparable long and permanent disability and could have been avoided if early operation had been done.

Now remember, I am referring to those cases where the skin and soft tissues are in good condition. If these are contaminated and in poor condition, then such time should elapse for their complete healing before operating. That is only sound surgical judgment. Our doctors are now so thoroughly trained and warned of the dangers and pitfalls of fractures that affirmation on the part of the orthopedists for earlier and more frequent open bone work would not result in wholesale operations by everyone in all fractures. Open bone work was looked upon with horror and dread—justly so, years ago. With the present-day teachings, improvement of technique, better trained surgeons, and our excellent hospital facilities, those dangers are little as compared with the numbers of poor results obtained by a forced operation after too long immobilization and extension when the injured's resistance has become extremely low. I say if fractures of the long bones, when uncomplicated, cannot be reduced, conservatively, in six to ten days, do the open operation. In these cases, especially of the legs, weight bearing can be started with safety and without bowing, much earlier than could possibly happen if treated by the closed method.

BLOOD PRESSURE AND GOITER*

By John Martin Askey, M. D.
AND
Clarence G. Toland, M. D.
Los Angeles

Discussion *by Robertson Ward, M. D., San Francisco; B. O. Raulston, M. D., Los Angeles; John C. Ruddock, M. D., Los Angeles.*

THYROTOXICOSIS is a commonly accepted cause for hypertension and must be ruled out in the study of any patient with high blood pressure of undetermined origin.

This is the prevailing impression despite certain experimental evidence pointing to the contrary. Intravenous injection of extracts of exophthalmic goiters by Blackford, Sandiford, and others has produced marked reduction of the blood pressure and has indicated the presence of a depressor substance in the thyroid extract. Reduction occurred only with exophthalmic goiter extracts, not with adenomas, colloid goiters or normal thyroids, and occurred only after the first injection. Apparently a tolerance toward further injections was established.

Some have reported cases tending to show low blood pressure as the typical finding in exophthalmic goiter, but the groups studied have been small.

On the other hand, Plummer in 1915 found a high percentage of hypertension in goiter patients over forty, namely, 47 per cent of the hyperplastic group and 35 per cent of the nonhyperplastic group.

TYPICAL BLOOD PRESSURE IN EXOPHTHALMIC GOITER

The blood pressure typically described in exophthalmic goiter is that of an elevated systolic pressure with a normal or lowered diastolic and a consequent elevation of the pulse pressure. The peripheral vasomotor phenomena, with the wide-open capillaries aiding in heat dissipation, tend toward a lowered diastolic pressure, and the increased systolic pressure is considered compensa-

* Read before the July meeting of the American Association for the Study of Goiter at Seattle, Washington.